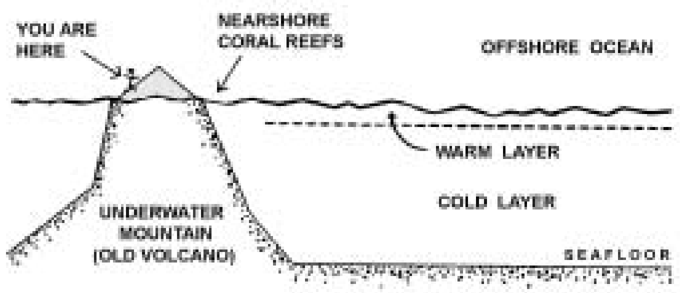
5. Our deep blue ocean

American Samoa is much larger than you might think it is. The whole Territory covers 117,500 square miles, which is about the size of New Zealand or the state of Oregon. The Territory is big because we claim jurisdiction of the ocean that surrounds American Samoa, from the shoreline out to 200 miles offshore. That is standard procedure throughout the world (each country with marine coasts wants to protect its coastline and marine resources from others). To be more precise, American Samoa has jurisdiction over territorial waters out to 3 miles, while the US federal government maintains control of the zone from 3 to 200 miles from shore.



Most of the Territory is open ocean, of course. Only a minuscule 0.1% of the area consists of dry land (all 7 islands total only 76.1 square miles). The other 99.9% marine portion consists of two main habitats - - the shallow coastal waters adjacent to the islands (*a'au, aloalo*) and the deep waters offshore (*vasa*). Shallow coastal habitats, with their coral reefs and colorful fish, are quite limited in total area because our islands slope steeply down into deeper water and depths of 2000 feet are reached within 0.5- 2 miles from shore. So, most of our coral reefs are restricted to a narrow ring around each island. In total, we have about 114 square miles (296 km^2) of coral reefs in the Territory.

The rest of our marine environment consists of deep blue ocean with a fairly flat seafloor about 2- 3 miles below the sea surface. The reason for the blue color of the ocean is an interesting one and it is a key factor to understanding our ocean ecosystem, so we need to get technical for a moment. Water by itself is highly transparent with a bluish tinge. What adds other colors to the ocean are, in large part, small marine plant- like cells called phytoplankton. The more phytoplankton in the water, the greener the water becomes. Phytoplankton require two main ingredients to grow well: sunlight and nutrients (fertilizers). If they have both, they grow in abundance. This, in turn, supports a productive food web: phytoplankton provide food for the microscopic shrimp- like animals (zooplankton), and the zooplankton provide food for the fish to eat.

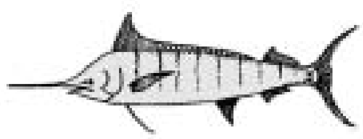
Tropical oceans are not green because conditions are generally not good for plant growth, so relatively few phytoplankton cells are present in the water. Although phytoplankton have all the sunlight they could ever want in the surface layer, nutrient levels there are too low to support much plant growth. This occurs because the deep tropical ocean is typically stratified into two layers with very different temperatures. The sun heats up the surface layer, which is about 300 feet deep, to a pleasant 84° F, but the deeper layer remains a chilly 42° F. Because warm water is lighter than cold water, the warm ocean water almost always stays on top, the cold water stays on the bottom. The two layers do not mix.

That's the rub. The bottom layer is where the nutrients are, but because of the 2- layer stratification, the nutrients can't get up to the surface layer where they are needed to combine with sunlight for plant growth. So, conditions for phytoplankton are not very good in the tropical ocean. The surface layer has lots of light but few nutrients, while the bottom layer has lots of nutrients but no light. It's pitch black down there. This arrangement doesn't support a very productive foodweb, so there are generally fewer fish in tropical oceans than in non- tropical oceans.

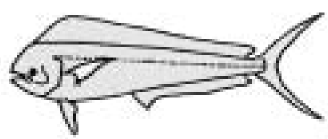
You might wonder, how is it that non- tropical oceans are much more productive? The answer is, again, temperature. Away from the tropics, seasonal changes in water temperature cause the water to mix. Winter temperatures cool the upper layer causing it to sink and mix with the bottom layer, and when this occurs, some nutrients are brought up to the surface. The nutrients in shallow sunlit waters stimulate phytoplankton growth, thus fueling a more productive foodweb.

In the tropics, the 2- layer stratification of the ocean persists year- round because hot sun keeps the surface layer warm. The tropical ocean has been called a 'biological desert' for this reason. That's an exaggeration, of course, because all the tuna out there are finding something to eat. And, many other species live out there as well, from an occasional whale, dolphin, sea turtle or seabird, to numerous species of fish and invertebrates such as jellyfish and shrimp- like crustaceans.

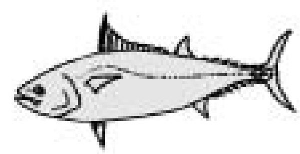
What are some of the marine resources in our offshore waters? Three ocean resources of potential interest to American Samoa are fish, minerals and the water itself. Several kinds of food and sport fish are present in modest numbers: tuna, *masimasi*, marlin, wahoo, sharks, and flying fish.



Marlin (*sa'ula*)



Mahimahi (*masimasi)*



Tuna (*atu*)

Surveys indicate, however, that the abundance of oceanic fishes within our 200- mile limit is probably not high enough to warrant significant commercial development of offshore fisheries. That's the main reason why the big tuna boats that deliver to American Samoa's canneries have to travel far beyond our 200- mile zone to other locations where the tuna are more abundant.

Another resource mentioned from time to time are the mineral deposits, such as manganese nodules, that lie on the seafloor. However, these nodules, even if present in our waters, are too deep for economic extraction by current technologies.

Perhaps a more exploitable resource in the future involves the temperature of the ocean's cold bottom layer. Scientists are working on a technology that extracts energy (to produce electricity) through a heat- exchange mechanism that is made possible by the large temperature difference between the tropical ocean's warm surface and cold bottom layers. A demonstration facility for this technology has been operating in Hawaii since the 1970's. The two requirements for this technology - - a large temperature differential in the ocean, and easy access to this temperature difference by land- based facilities - - are met in American Samoa. Will our future electricity needs be powered by our own blue ocean?

P. Craig
NPS

6. What is coral?

The islands of American Samoa are blessed with an abundance of coral, so this article presents an introduction to these unusual organisms.

Several types of corals on our reefs

Corals are animals like ourselves, although that may not be readily apparent because many look like whitish rocks, especially those washed up on the beach. In a sense, corals are indeed partly rock, because only the outer thin layer of the coral is inhabited by the coral animal itself. In that way, corals are like large trees – the inner part is hard and provides structural support, the outer part is the living, growing organism. And, like trees, most coral animals are permanently attached to one spot on the reef.

The coral rubble that Samoans traditionally spread outside their houses, and the coral rocks along our beaches, are old, dead pieces that broke off the reef during a storm, got tumbled around and tossed up on the beach.

Living corals grow primarily on the outer reef flat and in deeper water. Although they take varied shapes, the coral animals inhabiting the surface of all these types are similar. They look somewhat like miniature sea anemones (*matamalu*, *ulumane*) or upside- down jellyfish (*alualu*) with short tentacles that give the coral a slightly fuzzy appearance when the tentacles are extended. Each single coral animal is called a polyp, but the coral branch or block we see on the reef is actually not a single animal but a colony of hundreds or thousands of tiny polyps living side by side, giving the appearance of being a single coral animal.

A polyp with tentacles extended

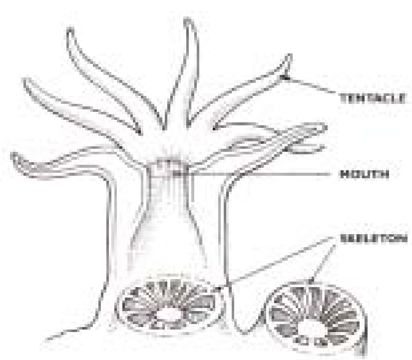
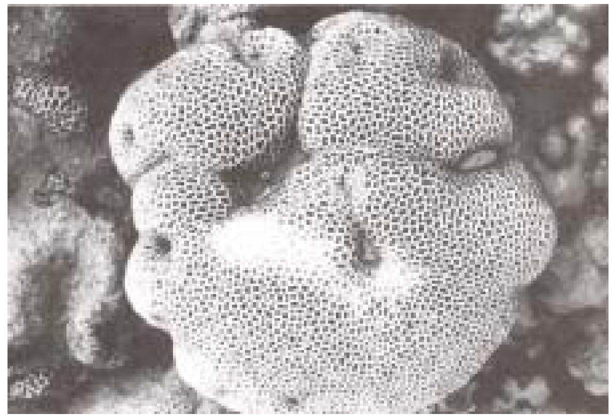


Diagram of a polyp

The coral's short tentacles can be pulled back into the hard part of the coral when the animal is disturbed or when the coral is exposed at low tide, so even a live coral can look like a rock at such times.

In the coral shown here, a single polyp lives in each hole. Together, they form a colony of polyps.



It seems almost inconceivable that these tiny coral polyps can build the hard coral 'rocks' that we see on the reef. They do this by secreting layers of a hard substance (calcium carbonate) beneath their living cells. It's as if each tiny polyp built a rock- solid house for itself but then, as it grows taller, it decides to close- off the bottom rooms in its house. Then it grows some more and closes- off another layer of bottom rooms, and so on. In this way, the coral polyp always lives in the outer, top layer, which has been built upon layers and layers of rooms below.

Each polyp also cements its high- rise house to those of its adjacent neighbors which strengthens the whole structure, resembling a solidly built apartment complex. Adding on these new rooms is a slow process. Growth varies from about 0.5- 3 inches per year depending on the species. The very largest corals on our reefs may be hundreds of years old. Over very long time periods, these corals grow into massively strong reef structures that can bear the brunt of powerful waves that crash upon them day after day.

Corals are one of the few organisms on earth that continually build on top of their old 'houses', forming such large solid structures. This is not like a bird that might build its nest on top of another nest, because both of these nests decay and disappear in a short time. In fact, most organisms on earth leave little trace after they die as their bones or shells disintegrate (dust to dust). Not corals. They build structures much larger and longer- lasting than the Pharaoh's pyramids. What other organism can do this (except modern man with his steel and cement)?

Consider Swains Island or Rose Atoll, for example. Both are the remnants of old volcanos that, after millions of years, finally sank back down beneath the ocean's surface and disappeared altogether as volcanic islands usually do (see Chapter 4). But as they slowly sank, the coral continued to grow on top of the submerged mountain tops, layer by layer, keeping pace with the sinking rate of the mountain. The thickness of the coral there now is probably hundreds or thousands of feet thick on top of the old mountain peak and it's all that's left poking above the ocean surface. Were it not for this thick coral foundation on top of these old mountains, Swains Island and Rose Atoll would not exist today.

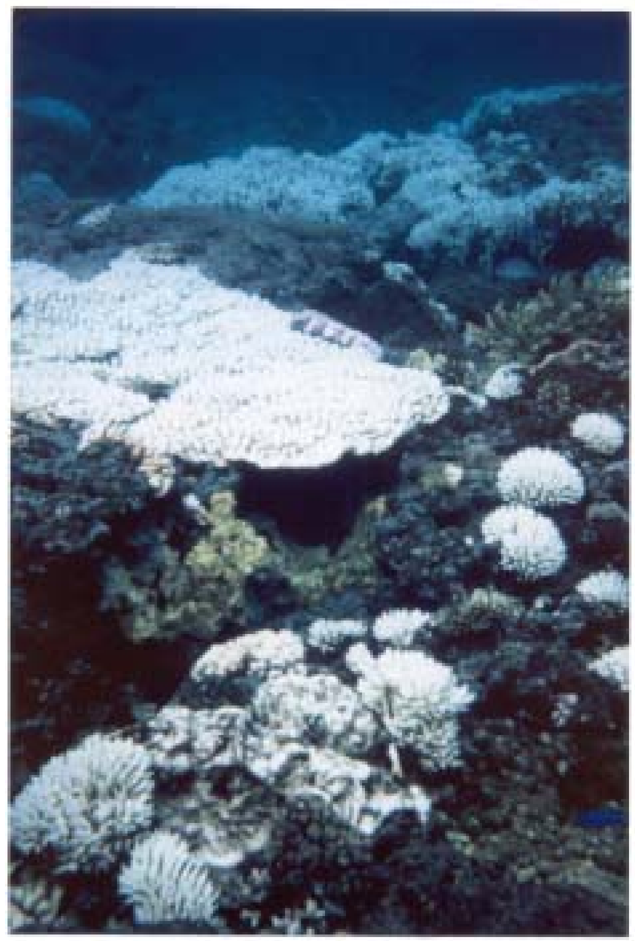
P. Craig
NPS

7. When corals turn white and die

In recent years, coral reefs in American Samoa have turned pure white on several occasions. They look freshly bleached, quite pretty, but that's a clear sign that things are bad for them.

Two very different kinds of stress cause corals to turn white - - (1) clorox bleach, and (2) warm water temperatures. Clorox bleaching happens from time to time when a foolish fisherman dumps clorox onto the reef to kill fish. This is very short- sighted because it also kills everything else in the vicinity - - young fish, crabs, snails and corals – and that harms the reef itself and reduces everyone else's catch.

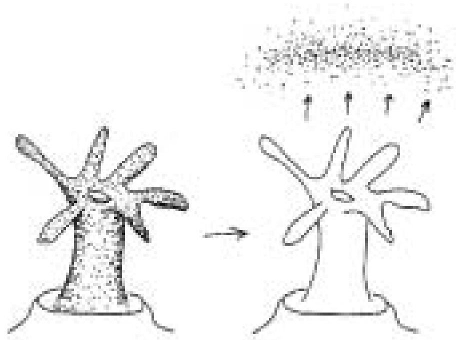
Nature can also cause the coral to bleach with extra warm water temperatures. It only takes a slight increase above normal water temperature to bleach the coral. Bleaching can be caused by a short-term exposure (1- 2 days) at temperature elevations of 3- 4 degrees, or by long- term exposure (weeks) at elevations of only 1- 2 degrees. To a diver, this may look like a pretty snowfall on the reef, but it indicates that the reef is seriously stressed.



Underwater photo showing several kinds of coral on our reefs that turned white, or "bleached", due to heat stress in 1994.

It seems odd that corals will die when the water gets slightly warmer, because most corals live only in warm tropical waters. Nonetheless, they live close to the hottest temperature that they can tolerate, so it doesn't take much to push them over the limit.

To explain what is happening, recall that corals are animals with colorful plant- like cells (zooxanthellae) living in their tissues. These cells use the sun's light to produce food, which is shared with the coral animal. Many coral animals receive much of their food this way, so this relationship is quite important to the coral animal. The animal, in turn, provides the zooxanthellae with nutrients and a secure place to live. Both the coral and the zooxanthellae benefit from this arrangement.



Normal coral polyp with plant-like cells inside the coral's tissues.

Heat-stress causes the coral polyp to release its plant-like cells.

When the coral is stressed by warmer than usual temperatures, the zooxanthellae are released from the coral, for reasons known only to them. What's left is a rather colorless coral animal overlying a bright white coral skeleton (see drawing). The animal portion of the coral may eventually recover its zooxanthellae and continue living, or it may die, depending on how stressed it gets. It's easy to tell when portions of the coral die because they become covered with fuzzy green algae.

A little bleaching occurs here during most summers, but it was particularly bad in 1994. Not all coral species were affected then, but those in shallow waters were hardest hit, and some bleaching down to the 130- foot depth was observed. Bleaching occurred again in 1998 when we experienced very low tides due to a strong El Nino event. The exposed corals turned white and died. In more recent years, we have narrowly escaped major bleaching incidents that hit nearby Fiji and western Samoa, but fortunately the area of warm ocean waters that caused the bleaching did not extend as far northeast as American Samoa.

Scientists predict that episodes of warm water temperatures will become more frequent due to a general warming of the earth. That's bad news for us. While it's unlikely that all of our corals will die off as the environment gets warmer, the number of corals here may well decline. That could cause two problems in American Samoa. First, a reduction in coral growth and number of species could reduce the diversity of habitats used by fish, so a downturn in fish catches from the reef could occur. Second, the reef itself could begin to erode, allowing more storm waves to reach our shorelines and cause damage to roads and houses. Both of these changes would probably occur at a slow but steady pace over the next 50 years.

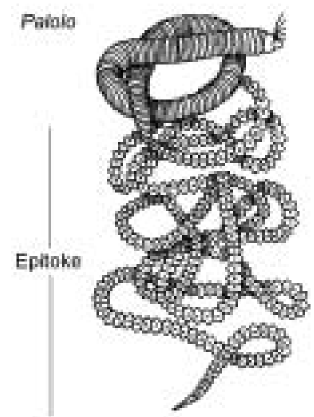
What to do? Not much, unfortunately, because American Samoa has little impact on the world's changing climate. On the other hand, it makes sense not to worsen the situation by further stressing our coral reefs with rubbish, sewage from piggeries, or dirt (sediment) from land- use activities that flows into streams and out onto the reefs. Additionally, we should also identify and protect any areas where corals appear to be naturally resilient to bleaching events. These hardy survivors could then help re- seed other areas where the corals had died.

P. Craig
NPS

8. Palolo swarming

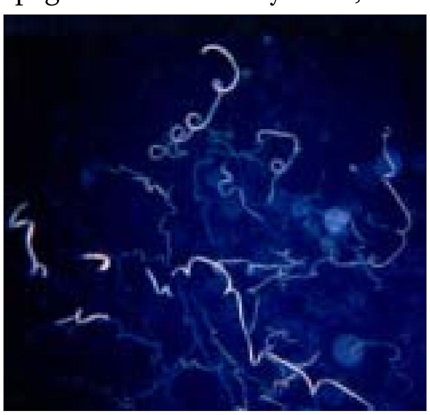
Once or twice a year, *palolo* swarm to the surface of the sea in great numbers. Samoans eagerly await this night and scoop up large amounts of this delicacy along the shoreline with hand nets. This gift from the sea was traditionally greeted with necklaces made from the fragrant *moso'oi* flower and the night of the *palolo* was and still remains a happy time of celebration. The rich taste of *palolo* is enjoyed raw or fried with butter, onions or eggs, or spread on toast.

Palolo is the edible portion of a polychaete worm (*Eunice viridis*) that lives in shallow coral reefs throughout the south central Pacific, although they do not swarm at all of these locations. This phenomenon is well known in Samoa, Rarotonga, Tonga, Fiji, the Solomon Islands and Vanuatu.



Palolo are about 12 inches long and live in burrows dug into the coral pavement on the outer reef flat. The worm is composed of two distinct sections (see drawing). The front section is the basic segmented polychaete with eyes, mouth, etc., followed by a string of segments called the "epitoke" that contain reproductive gametes colored blue- green (females) or tan (males). Each epitoke segments bear a single, tiny eyespot that can sense light (that's why islanders are able to use a lantern to attract the *palolo* to their nets).

When it comes time to spawn, *palolo* will back out of their burrows and release the epitoke section from their body. The epitokes then twirl around in the water in vast numbers and look like dancing spaghetti. Around daybreak, the segments dissolve and release the eggs and sperm that they contain. The fertilized eggs hatch into small larvae that drift with the plankton until settling on a coral reef to begin life anew.



Palolo underwater

The swarming of *palolo* is a classic example of the coordinated mass spawning of a simple marine organism. The worms emerge from their burrows during a specific phase of the moon, but the actual date is a bit complicated. The swarms occur on the evenings of the last quarter moon of spring or early summer. In Samoa, this is seven days after the full moon in October or November. Swarming occurs for two or three consecutive nights with the second night usually having the strongest showing.

Palolo usually appear here in October, but sometimes in November or sometimes during both months. This difference is due to the fact that there are approximately thirteen lunar months in one calendar year and the *palolo* use primarily the moon to time their spawning activity. However, if they always spawned every twelve lunar months, their time of spawning would occur earlier every year. After a few years, they would be spawning in August or July (midwinter). In order to make up for this difference, the worms will delay spawning in some years to the thirteen lunar month.

The fact that *palolo* adjust their spawning time means that there are other factors beside the moon that determine the time of year they begin to mature and are ready to release their epitokes. Several studies on this matter have suggested that rising seawater temperatures, tides, weather, moonlight or other biological signals may play a role in starting the maturation and release of the epitokes. Once the swarming begins, the presence of the *palolo* spawn in the water probably stimulates other *palolo* to release their mature epitokes.

<u>Rules For Predicting Emergence</u>. Everyone seems to have their own methods for predicting when the best *palolo* rising will occur. Several natural clues that preceded the *palolo* rising enabled islanders to predict the correct timing for *palolo* swarming. These included the flowering of the *moso'oi* tree, the closing of the *palulu* flower (a morning glory), a strong smell from the reef, brown foamy scum (from coral spawn) on the ocean, toxins occurring in reef fish, and abrupt weather changes or bad weather such as thunderstorms or lightning.

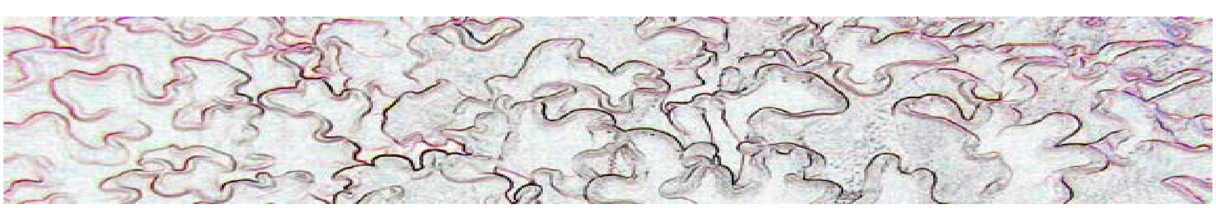
So, will *palolo* swam seven days after the full moon in October or November? One set of rules used to predict the main night of emergence depends on the calendar date of October's third quarter moon (seven days after October's full moon). If it occurs:

1. From October 1 to 8, *palolo* will not appear until November.
2. From October 8 to 18, *palolo* will not appear in October or the swarming will be weak followed by a stronger appearance in November.
3. From October 19 to November 7, there will be a single, strong swarming centered on this date.
4. From November 8 to 17, there will be a strong appearance on this date, possibly following a weaker swarming during the previous month (see number 2 above).

To further complicate matters, the actual time of emergence of *palolo* in Samoa differs between islands. They usually appear around 10 pm in the Manu'a Islands (however, it has occurred at 1 am there), 1 am on Tutuila and closer to 4 or 5 am in western Samoa. This difference is somewhat consistent from year to year and cannot be accounted for by difference in tides or moonrise. The difference in tides between islands is far less than one hour and the time of moonrise is only minutes apart.

A good catch of palolo

David Itano
DMWR



9. Giant clams (*faisua*)

Giant clams (*faisua*) are magnificent animals and it's always a pleasure to see one of these beauties on the reef. They are large, colorful and, surprisingly, the clams are part animal and part "plant". That's because giant clams, like corals, have plant- like cells (zooxanthellae) in their tissues that produce free food for the clams. When a clam opens its shell and spreads out its pretty mantle, it exposes these solar panels (the zooxanthellae) to the sun to make food, like a plant unfolding its leaves.

At the same time, the clam also gets some food by drawing water through its siphon and filtering out any tiny food particles (zooplankton). Perhaps that's why giant clams grow so large – they have two very different ways to get food.

We have two native species of giant clams in our local waters, *Tridacna maxima* and *T. squamosa,* which look fairly similar. They grow to about 12- 15 inches in shell length, although most found today are much smaller because the larger ones have been over- harvested. The largest and most famous species of giant clam (*T. gigas*), which grows as big as a large suitcase, does not occur in our waters.

Because giant clams need sunlight, they inhabit shallow, clear waters down to about 60 feet deep. They grow very slowly; one local clam was 18 years old. They spawn repeatedly over their life span and release millions of eggs each time they spawn, but most young clams do not survive, so the adults have to live a long time and spawn many times to insure that the population survives. Larval clams swim in the water for about a week, then settle permanently onto the reef to grow.

The clams are a favorite food item throughout the South Pacific and their accessibility in shallow waters and slow growth make them susceptible to overfishing. That is very much the case in American Samoa, where few remain on many of our reefs. There is a growing concern that our population of giant clams may be getting too few and far between to spawn successfully.

Partly for that reason, there has been an interest in growing these clams in hatcheries to supply markets for food and the aquarium trade. DMWR has operated a hatchery here for many years and tried to encourage local production by supplying small clams for local 'farmers' to grow them on their reefs. That effort has met with limited success for several reasons. Considerable dedication is needed because it may take years to grow the clams to a commercial size, and the clams have to be protected from poachers and predators. And there are always *fa'alavelave* events that call for contributions of giant clams if anyone has some. In general, giant clam mariculture here has usually supplemented family needs rather than create a commercial business.

Harvest regulations in American Samoa are: giant clams taken for personal consumption must be at least 6 inches in shell length, or if sold, a license is required and giant clams must be at least 7 inches in shell length and sold with the clam still in its shell.

P. Craig, NPS

10. Sharks

We are quite fortunate not to have much of a "shark problem" in American Samoa. Based on conversations with long- time residents here, it appears that there have been very few shark attacks in the Territory and probably no fatalities here in the past 30 years.

The few injuries that have occurred were usually related to fishing activities, and records from the hospital's Emergency Medical Services concur with this. EMS has responded to only one or two shark incidents in recent memory – one was a somewhat humorous account of two fishermen trying to land a shark in their boat. The first fisherman brought the shark up to the side of the boat so that his partner could club it, but his partner missed. The shark then reared up and bit the first fisherman, who then got mad and clubbed his partner for missing the shark.


Blacktip reef shark
(malie)

The sharks (*malie*) living in our nearshore waters are generally not dangerous to swimmers or divers. The most commonly seen species are the blacktip reef shark (*Carcharhinus melanopterus*) and the whitetip reef shark (*Triaenodon obesus*). These are not large sharks, usually about 4- 5 feet in length, although everyone swears that the one they saw was bigger. They feed on fish and shellfish. The whitetip has an unusual habit of resting occasionally on the seafloor during the daytime.

These two shark species are usually not aggressive but they may swim close by to see who's in their area. But both are attracted to wounded and bleeding fish, which accounts for several shark encounters with divers who had tied speared fish around their waists. Need it be suggested that this is not a smart thing to do?

The blacktip is easily frightened away, but on rare occasions small blacktips will sometimes startle a person by swimming directly at them. They look like a little torpedo coming straight at you, but other than your brief panic attack, no harm is done. Another quirk of the adult blacktip is that, at night, it may charge at a diver's light if the light shines on them for too long.

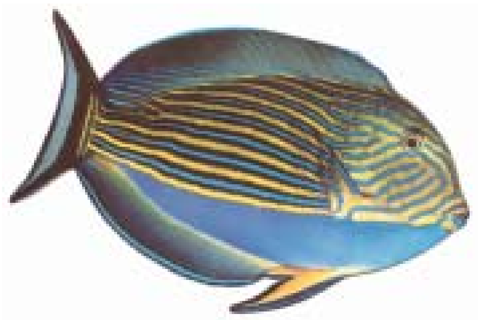
Sightings of more dangerous sharks in our nearshore waters are rare, but over the years, a few tiger sharks have been seen or caught around Tutuila. Also, hammerhead sharks are known to swim into Pago Pago Harbor, where some give birth to young and others are perhaps attracted there by the cannery wastes.

So, yes indeed we have sharks in our shoreline waters, but most are not of serious concern. Yet, someplace deep in our brain yells Danger! whenever we see one. But it is still very exciting to see a shark swim by. Our heart rate jumps, but then the shark is quickly gone, and our only thought is wow, did you see that?

P. Craig
NPS

11. The *alogo* surgeonfish -- ruler of the reeftop

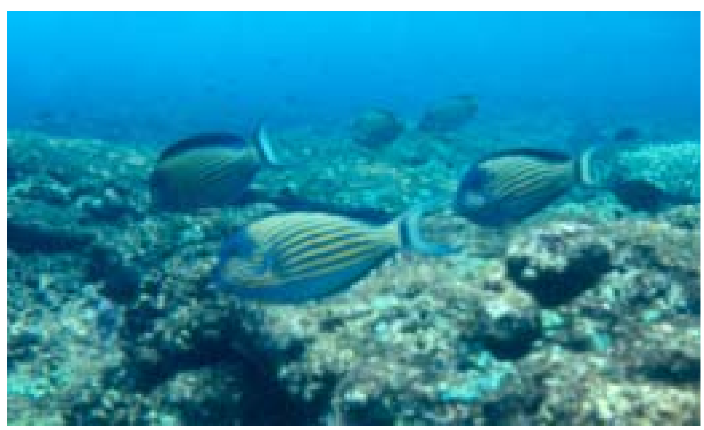
American Samoa's coral reefs are truly a wonder of nature. Our sea is home to a very diverse and colorful assemblage of plants and animals. Some 890 species of fish occur here, which is about twice the number of fish species found in Hawaii.



At first glance, the reef seems to be an exotic panorama of mass confusion, complete with bizarre shapes of fish painted in psychedelic colors. It's like looking into an overstocked aquarium. But as you frequent the reef more often, you begin to notice some structure to the confusion. Each species, for example, is generally found only in certain habitats such as shallow reef flats, sandy bottom areas, or deeper waters.

Many individual fish even take up permanent residence at a particular site rather than roam around. One particular fish I watched stayed at the same coral block for 3 years (it had a unique markings on its body, so I could easily identify it). That coral block was home.

Such stay- at- home behavior is actually quite common among coral reef fishes. One abundant species on our reefs that does this is the *alogo*, also known as the blue- lined surgeonfish (*Acanthurus lineatus*) because of its knife- like blade located near its tail. The blade is usually not visible because it is folded away into a groove in the fish's skin. It is a bit poisonous, and careless handling of the fish may cause a puncture and painful swelling in your hand.



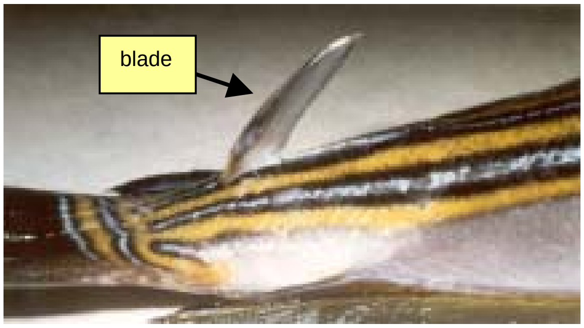
The *alogo* grows about 8 inches long and weighs half a pound. It is a very attractive fish, with bold yellow, blue, and black horizontal lines on its sides, although its basic color pattern can be swiftly altered depending on the *alogo's* mood. For example, when the *alogo* becomes aggressive and chases another fish, its face and fins darken and it looks angry (to me at least).

The *alogo* lives in the foamy surge zone where the waves crash against the reef. This is not an easy place to live, but the *alogo* is adept at it. When a really rough wave hits, the *alogo* darts down into a hole or over the reef edge into the safety of deeper water.

Like a lot of other reef fish, the *alogo* is a territorial animal, which means that it dwells at a particular patch of reef and protects that site from all other fish. The territory of each *alogo* measures about 5 x 5 feet. There it feeds on the thin film of plant material (algae) that covers the reeftop and appears as a greenish grassy turf. Because of their territorial nature, the *alogo* space themselves evenly across the reeftop, and as they munch away on the algae- covered rocks, they remind me of a herd of miniature cows feeding in a distant pasture.

Many other species of coral reef fish are also algae eaters, and two general patterns of feeding have evolved among these species. One is for a species to become territorial and fiercely guard its own algal patch, the other is to be non- territorial and roam around the reef looking for an unguarded patch of algae to eat. To an underwater observer, this dual approach to feeding is readily visible - - most of the reef is picked clean of all edible algae and looks like bare rock, except where a territorial fish guards its lush algal plot.

The feisty *alogo* defends its plot from all competitors, so the turf algae grows well there and provides all the food the *alogo* needs. Protection of this garden doesn't come cheaply, however. The *alogo* must defend its territory every minute of the day from other fish that lurk nearby, waiting for a chance to sneak in and eat the *alogo's* garden.



That's where the *alogo's* sharp blade comes in handy (see photo). The *alogo* will threaten to viciously sideswipe an intruder with this weapon. Most other fish heed the *alogo's* warning and back- off quickly. It's mostly a bluffing game played repeatedly through the day.

Other aspects of the *alogo's* behavior are fascinating. Every evening at dusk, all the *alogo* migrate off the reeftop to deeper waters where they will spend the night sleeping in crevices to escape being eaten by predators like sharks (*malie*) and jacks (*malauli, ulua*). At dawn, they return by the same route. Their migrations to and from the reeftop look like rush- hour traffic on an underwater highway.

The *alogo* is a popular Samoan food fish and it is the singlemost important species of reef fish caught, accounting for about 30% (by weight) of all reef fish caught in the nearshore subsistence fishery. Most are caught by spear fishermen, particularly at night when the fish are sleeping in reef crevices. Daytime spear fishermen have a much harder time catching them, because the *alogo* tend to stay just out of spearing range.

P. Craig
NPS

12. *Manini* and *pone* -- two favorite reef fish

Manini and *pone* are two favorite food fishes found just about everywhere in shallow waters around the islands of American Samoa. Like *alogo*, they belong to the family of fishes called surgeonfish because of their sharp knife blades that fit into grooves near their tail. *Manini* and *pone* are rather meek fishes, however, and they do not seem to wield their weapons much.

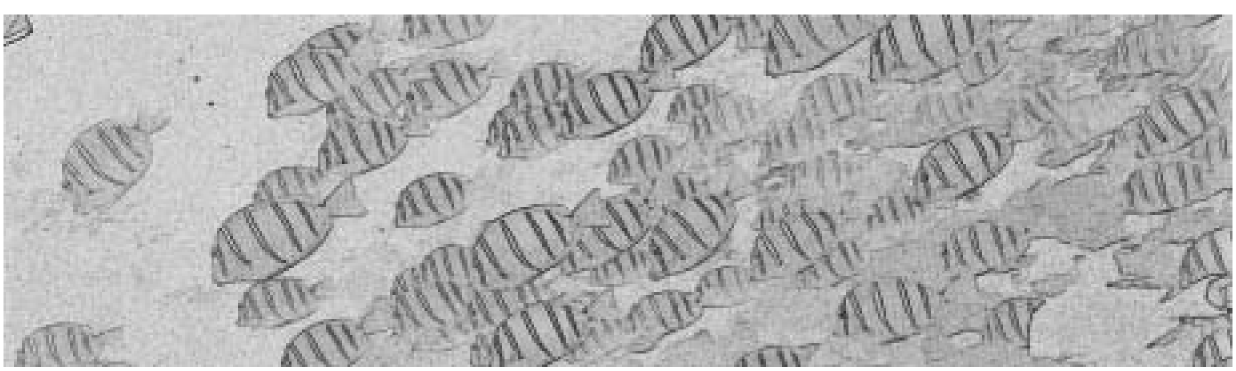
The *manini* (*Acanthurus triostegus*) is a small fish about 5 inches long. Its coloration is yellow with vertical black bars, which looks a bit like a prisoner's uniform and that's why this fish is also called the convict tang.

Manini often swim in large schools containing hundreds or thousands of individuals. There are two good reasons for this schooling behavior - - it helps them escape predators and it also helps them get access to food. First, when a large fish attacks a school of *manini*, the *manini* scatter in all directions like a shotgun blast. This commotion momentarily confuses the predator and the *manini* get away. Each *manini* thus has a better chance of not getting eaten if it stays in a group.

The *manini* also cleverly use their schooling behavior to get food. They like to feed on the thin green algae turf that grows on reef rocks, but these algae patches are usually guarded fiercely by *alogo* surgeonfish and damselfishes (*tu'u'u*) who are nasty to intruders.

Just the sight of a *manini* gets them livid with rage. A single *manini* would not stand a chance to get by these guards, but a large group of *manini* can succeed. The *alogo* and damselfishes are simply overwhelmed when hundreds of *manini* descend into their protected territory to feed. While the *alogo* futilely chases one *manini* away, a hundred others are gobbling up its garden.

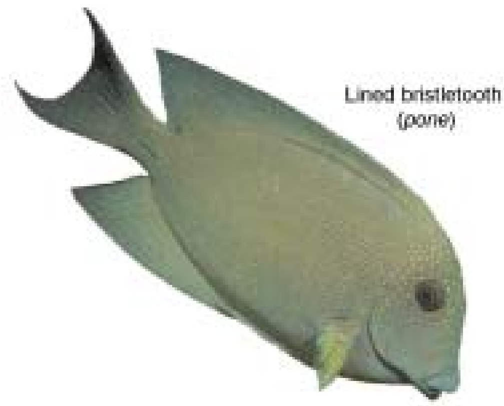
Manini spawning is a spectacular event. When conditions are right, thousands will assemble to spawn at a particular time and place. They often spawn in or near the reef channel (*ava*) at dusk when the tide is high. Their behavior and coloration is noticeably different at this time, as they swim around in a agitated fashion and change color to white with wider black bars.



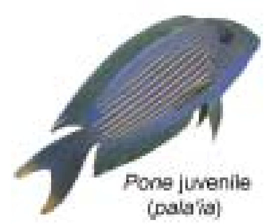
This seething mass of fish mills about until they can't take the excitement any longer. A group of them will suddenly burst upwards in the water column, spawn, and return to the seafloor again, all in a split second. Although this happens fast, you can tell that the fish actually spawned because the milt expelled by the male fish looks like a puff of smoke from a gun. When the spawning action really gets going, it looks like an underwater version of popcorn popping.

After spawning, the fertilized eggs drift away with the currents. About 1- 3 months later, the small *manini* that survived this larval stage are ready to settle back onto the reef.

Pone (*Ctenochaetus striatus*, or the lined bristletooth surgeonfish) are a different type of surgeonfish in two respects. They are a dull brown color and they have funny teeth. Their lack of spectacular coloration is somewhat of an embarrassment in tropical waters which are renown for brightly colored fish. *Pone* are, however, one of the most abundant fishes on the reefs, so they must be doing something right.



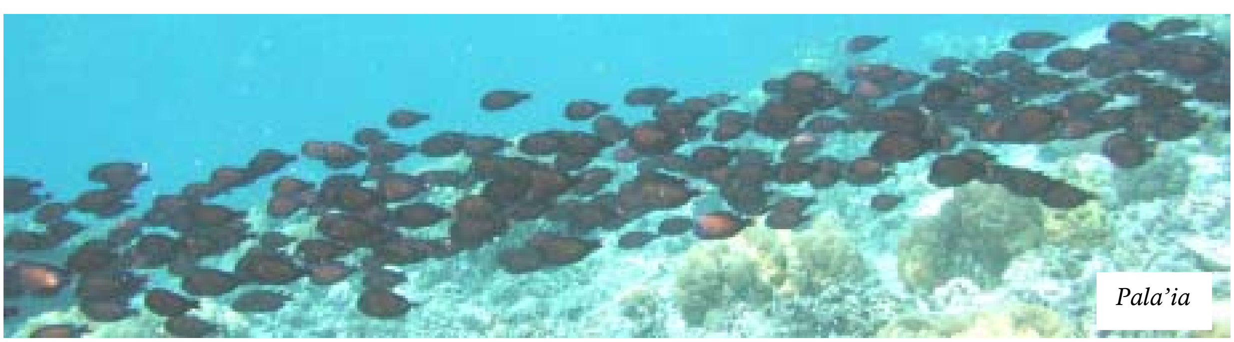
Their teeth have evolved very differently from other surgeonfishes because what they feed upon is quite different. Instead of having actual teeth to bite off algae the way that *alogo* and *manini* do, *pone* have a mouthful of bristles which they use as a comb or brush to collect the sediment and detritus that lies on reef surfaces. The detritus they eat includes all the small bits and pieces of formerly living plants and animals. The detritus in your backyard, for example, might include grass clippings, old *ulu* leaves, decaying coconut husks, rotting papayas, and numerous unseen dead insects.



Detritus is found everywhere, but few large animals can make a meal out of it. *Pone* can, and that may account for their abundance and widespread distribution on coral reefs.

Every several years or so, *pone* have a very successful spawning event, and uncountable numbers of their young (*pala'ia*) settle onto the reef. *Pala'ia* are very pretty and look like small dark *alogo*. But their beauty fades as they grow, and in just a few weeks they turn brown in color.

P. Craig
NPS

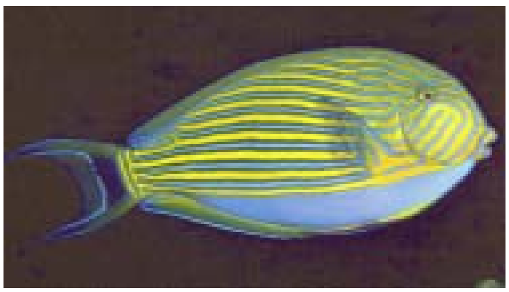


Pala'ia

13. Old fish caught in Samoa

This is hard to believe - - an 18 year old *alogo* was caught in American Samoa. That's old enough to get a drivers license.

We're talking about the *alogo*, also known as the bluelined surgeonfish *Acanthurus lineatus*. Nothing unusual about its size - - it was the standard 8- inch *alogo* you see in the stores. And I ate it. All that remained were the little bones that scientists use to determine the age of the fish. These bones, when looked at under a microscope, have concentric circles, one for each year, just like tree rings. You just count the rings and that's how old the fish is.



What's even more astonishing is that an *alogo* caught in Australia's Great Barrier Reef was 44 years old. I am not kidding. Reputable scientists determined the age of that fish. There were also other *alogo* in the Australian sample that were 20- 40 years old, so the record age of 44 is believable. These old fish were not unusually large, just the standard size *alogo*.

It turns out that this is not unusual for coral reef fish. Recent studies show that several other species of surgeonfish (*pone*), unicornfish (*ume*), groupers (*gatala*) and snappers (*mu*) can also live up to 20- 40 years. These findings are beginning to reshape our understanding about the ecology of coral reef fishes and their vulnerability to overfishing. The occurrence of many long- lived fish in a population indicates that the coral reef fish community is fairly stable, with a low replacement of individual fish. Once a young fish gets to the reef, it may be there for decades.

Why would these fish live so long? The answer provides some key information about the environment that the fish live in. Fish typically exhibit this type of life cycle (long life span and repeat spawning) when few of their young survive. That's certainly the case for coral reef fish – their thousands of eggs and larvae drift around with the ocean currents for weeks or months. Very few of them make it back to the reefs. So, if all their young usually die, the fish need to live a long time and spawn repeatedly to make sure that at least some young survive. If the adults lived only a short time, the population might disappear altogether.

I'asina in a basket trap

Every so often however, during years when the ocean currents and conditions are just right, massive numbers of young fish survive and appear on our reefs, like *pala'ia* (young *pone* surgeonfish) or *i'asina* (young goatfish).

While this is, of course, all very interesting, there is an important take- home message. It is easy to overfish populations with these life history characteristics. Having a long life span and spawning repeatedly may be a successful strategy under natural conditions, but it also makes these fish extra vulnerable to overfishing. That's because fishermen tend to harvest the larger (older) fish in the population. Under heavy fishing pressure, all the old fish may be taken, leaving only the smaller, younger fish. That would put the population in a very precarious situation, because the younger fish left may not yet be old enough to spawn. This type of overfishing probably occurred on Tutuila's coral reefs in the 1990s and may be continuing. It is a common belief that fish on our reefs are fewer and smaller than they used to be, and there is some scientific evidence to support this.

Two fisheries in American Samoa target these coral reef fish - - the subsistence fishery and the artisanal (small- scale commercial) fishery. Subsistence fishing includes the multiple ways that Samoans have always caught nearshore fish. These catches declined significantly in the early 1990s, but the current status is not known.

The artisanal fishery that sells reef fish to local stores is a relatively recent development. It is conducted by teams of night divers who use underwater flashlights and spears to catch sleeping fish. In the mid 1990s, many of these divers switched from free- diving to scuba diving, which greatly increased the number of fish they could take. It is likely that this type of fishing had a significant impact on our reef fish populations, so the use of scuba gear while spear fishing was banned in the Territory in early 2000.

So, that 18 year old *alogo* was not just an unusual trophy – it was also a vital member of the fish community that spawned year after year (for about 14 years after it reached maturity at age 4), thereby insuring that some young fish survived to maintain a healthy population of *alogo* on our reefs.

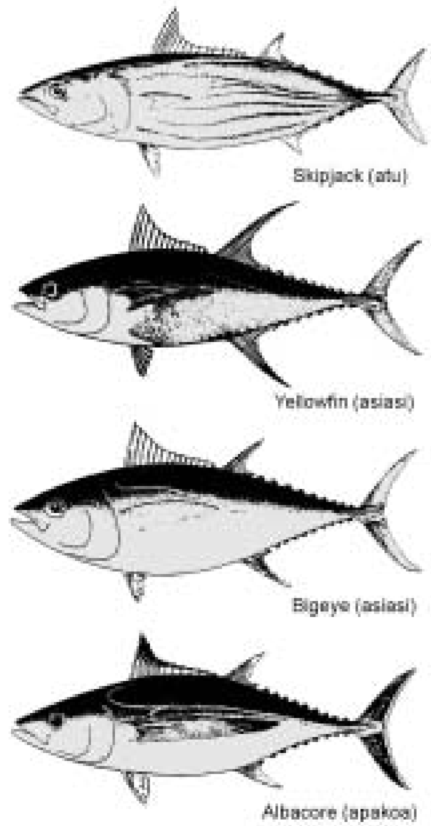
P. Craig
NPS

Fish for dinner

Roadside fish seller

14. Tuna

The ocean around us supports a variety of offshore fishes, such as *masimasi* (mahimahi), swordfish, wahoo and marlin, but by far the most commercially important of these pelagic fishes are the tunas. The most common in our local waters are albacore (*apakoa*), yellowfin (*asiasi*), skipjack (*atu*) and dogtooth tuna (*tagi*) .



Dogtooth tuna are occasionally seen near shore, but tuna prefer the open ocean and are wide- ranging species. These ultra- streamlined fish undertake impressive oceanic travels - - one skipjack was caught here that had been tagged near Australia over 2000 miles away. But the general movements of tuna in our area are not known.

Fishermen catch tuna in our area by trolling at FADs (fish aggregation devices), offshore seamounts, or wherever seabird flocks are feeding (the flocks indicate the presence of baitfish that the tuna are probably also feeding upon). In recent years, commercial catches of locally- caught tuna have increased in the longline fishery that targets albacore using long lengths (extending 5- 40 miles) of monofilament longline with baited hooks.

Given that American Samoa has two major tuna canneries and we are the No. 1 port in the United States in terms of value of fish landed (about $200,000,000 of tuna per year), it is somewhat surprising to realize that few of the fish canned here are actually caught within American Samoa's waters. That's because tuna are not particularly abundant in our area, so local catches delivered to the canneries amount to less than 1% of the 200,000 tons of tuna processed at the canneries each year. Commercial quantities of tuna are generally located 1000s of miles away from American Samoa, so the big purse seiners and foreign longliners that you see docked in Pago Pago Harbor do not fish locally. Instead, they must travel for about 1 week just to reach their distant fishing grounds. The reason why these boats deliver their catch to the canneries here is simply because the tuna canned in American Samoa can enter US markets tariff- free as “Made in USA”, and the US is one of the largest consumers of tuna.

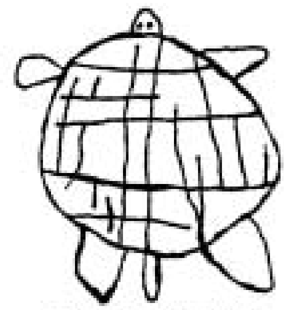
A rather enjoyable feature about tuna is that their meat generally lacks parasites, so people eat raw tuna in a variety of forms (*oka*, sashimi).

P. Craig, NPS

15. Turtles In trouble

In Samoan folklore, sea turtles were believed to have the power to save fishermen who were lost at sea by bringing them safely to shore. The Samoan word for sea turtle, "*I'a sa*," translates literally to "sacred fish", presumably because of this ability.

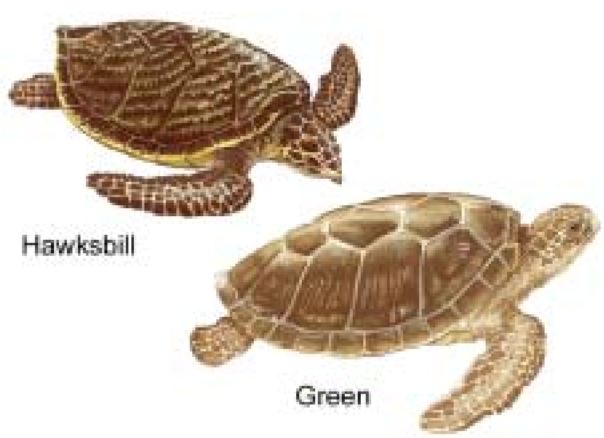
Samoans have traditionally harvested sea turtles for food, and the shell was often made into bracelets, combs, fishing hooks, and also was used in the headpiece worn by a princess during important dance ceremonies. Turtles were incorporated into Samoan songs and art, and there are even turtle petroglyphs (rock carvings) in Faga'itua and Leone. And, of course, there's the legend about the Turtle and Shark that appear in the sea at Vaitogi when villagers sing a special song.



TURTLE PETROGLYPH

It therefore seems extra unfortunate that turtle numbers in Samoa have declined so much that they are now considered endangered species. Although it is difficult to determine how many are left, it is clear that few females lay eggs each year in the whole Territory. This drop parallels the worldwide decline of sea turtles due to overharvest, loss of nesting beaches, and incidental kills in fishing gear. Pacific populations of one of our species (hawksbills) are "rapidly approaching extinction" according to a recent review.

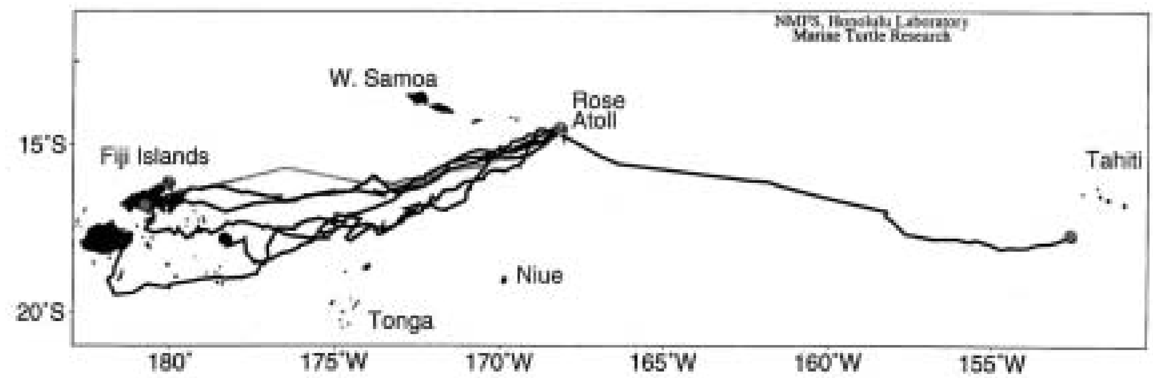
Two turtle species, the green and hawksbill, are the most frequently found turtles in our local waters. The hawksbill or "*laumei uga*" (*Eretmochelys imbricata*) is usually the species that nests on Tutuila beaches. This is a solitary nester, and perhaps only 1 or 2 hawksbill females now use a suitable beach. The hawksbill is occasionally poisonous - - in the late 1950s, many people in Aunu'u got very sick after eating one.



Our other species is the green sea turtle (*Chelonia mydas*), named after the color of its fat. It is also found around our islands, but it nests primarily at Rose Atoll. These long- lived turtles have rather complicated life cycles that involve repeated long- distance migrations to and from American Samoa. They start life as eggs buried in beach sand. Once a female has laid her first group of about 100 eggs, she will return at 2- week intervals to lay more. In about 60 days, the eggs hatch and the little turtles dart into the ocean. Where they go is not known, but eventually they take up residence at some feeding area that may be far away from American Samoa.

There they remain for some 20- 25 years until they become sexually mature, at which time they return to the very same beach where they came from. After laying eggs there, the adult females then turn around and go back to their distant feeding grounds. That's the basic pattern for most sea turtle species throughout the world. Swim far away to some nesting beach, then swim back to their feeding area, back and forth every few years thereafter.

We have some very interesting migration data for green sea turtles at Rose Atoll (see map below), where a tagging study was conducted in the mid- 1990s. In all, 10 tagged turtles were recovered after nesting at the atoll. Eight swam 800 miles directly to Fiji (unfortunately two of them were eaten when they got there). Another went past Fiji to Vanuatu, and the last one went in the completely opposite direction to French Polynesia near Tahiti.

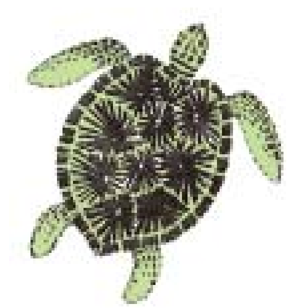


It's understandable why the adult turtles do not stay at Rose Atoll after nesting, because their favorite food (seagrass) is absent there. But I wonder why don't they just stay in Fiji where they have both seagrass and nesting beaches.

Anyway, this pattern of large- scale movements between a turtle's nesting area and feeding area means that turtle stocks in the South Pacific Ocean are all mixed together. While some of “our” turtles were caught in Fiji, the reciprocal is also true - - turtles that feed in our waters probably originated from islands elsewhere in the South Pacific. This mixing greatly complicates conservation efforts. It means that region- wide cooperation among the island countries of the South Pacific is essential; otherwise, while we try to protect turtles in American Samoa, our turtles may be killed later when they migrate to other islands.

Tough federal and territorial laws exist in American Samoa to protect turtles and their eggs, because they are an endangered species. There is a $10,500 penalty for killing a turtle or importing any turtle product into the Territory (shells, stuffed turtles, turtle combs, etc.). Fortunately fewer turtles seem to be taken in American Samoa, probably due to their scarcity but also due to outreach programs that inform children and villagers about the endangered status of the turtles.

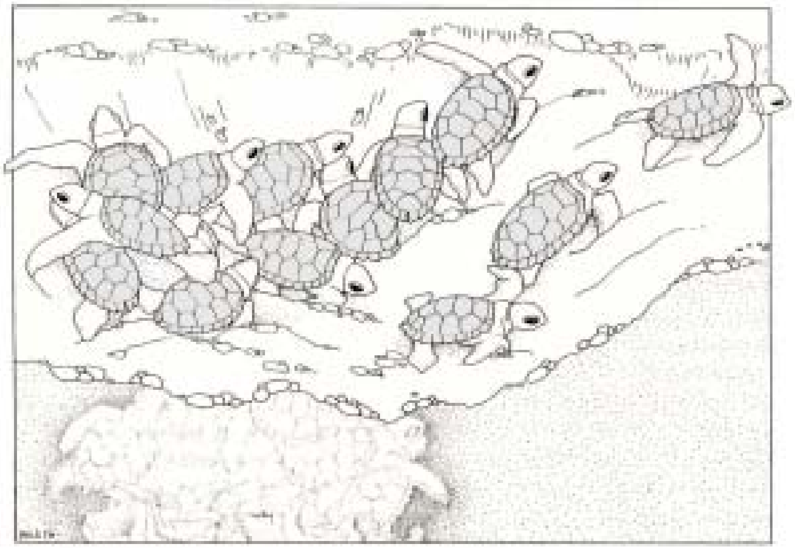
In addition to education efforts, we must protect both the turtles and their habitat. Sandy beaches are essential for turtle nesting areas, so hauling sand away from our beaches results in the loss of critical habitat for these species. No beaches, no nesting turtles.



Although some villagers may still like to eat turtle meat and eggs, the point to remember is that turtles are a disappearing resource in American Samoa. They are a part of Samoa's heritage and need to be vigorously protected, or they may be lost altogether. It is a sad commentary that many young Samoans have never even seen a live sea turtle.

P. Craig
NPS

16. Baby turtles: look but don't touch!



Baby sea turtles. They're so neat - - perfectly formed miniatures, all racing down the beach together to get into the water. Kids think they're cute and they want to keep them as pets, and plenty of parents think baby turtles make great pets. After all, they don't bark or fight, and they're so tiny so they don't take up much space. They don't eat much, either.

Also, some people in American Samoa believe that when a nest of turtles hatches and all the babies run to the sea, their mothers are waiting out on the reef to eat them! Because of this misguided belief, some people collect baby turtles and keep them at home or release them on a different beach. The very best thing we can do for baby turtles is: LEAVE THEM ALONE!

Many years of scientific research on sea turtles have taught us that mother turtles do not eat their babies. Adult turtles eat mostly seagrass, algae (seaweed), and sponges (the living kind, NOT the kitchen kind). In fact, after the female turtle has laid eggs (sometimes two or three times in the space of a few weeks), she goes back out to the sea and leaves the area. For example, after nesting at Rose Atoll, some of American Samoa's green sea turtles swam to Fiji − over 800 miles away! So, those of you with good intentions out there, rest assured that mom will not be eating her babies, and you do not need to collect the baby turtles from the beach to save them from her.

It is true that baby turtles do have predators, such as large fishes and sharks. Nature provides the turtles with some protection however: (1) most turtles hatch at night when predators might have difficulty seeing them, (2) baby turtles are dark- colored, and this "cryptic coloration" enables them to be camouflaged as they swim over the reef, (3) female turtles can lay over 100 eggs in a single nest — when this many turtles hatch at the same time, a big jack (*ulua*) or shark (*malie*) can't possibly catch and eat all of them, so some have a chance to hide in the reef. This is called "predator swamping" and is common among reptiles (lizards, snakes, turtles, etc.). For this reason it is a bad idea to take "just a few" baby turtles away, and release them later. The "predator swamping" effect is lost and those baby turtles will probably end up as some fish's lunch.

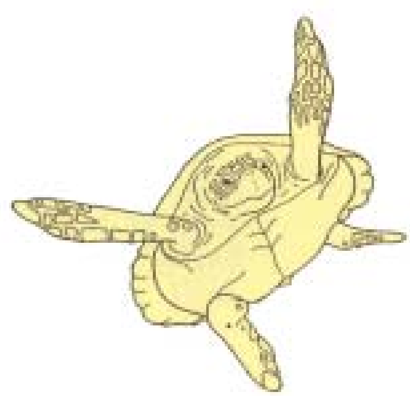
A critical reason to leave baby turtles on the beach is that THAT EXACT BEACH is very important to them. Baby turtles remember or "imprint on" the beach where they hatched. Like many animals, turtles have little natural magnets in their brains that allow them to home- in on their native beach. Years later when it's time for them to reproduce, adult turtles, with their internal "homing devices", will seek that same beach. If hatchling turtles are removed from their home beaches and kept in someone's bathtub or bucket, chances are they will become confused and have little chances of surviving, let alone finding their home beach later (that is, if they don't just die in the bucket).

Sea turtles have been around for millions of years and survived just fine before humans started taking their babies off the beach, whether to "protect" them or otherwise. Newly- hatched turtles, just like their gigantic moms and dads, are wild animals and are not meant to be kept as pets. The ocean provides better food and a cleaner, healthier environment for turtles than humans can.

Turtles are far- ranging animals that swim thousands and thousands of miles in the sea during their lifetimes. When they go to their nesting islands, they meet with other turtles, mate, lay eggs, and so keep their species alive. Every time a female sea turtle finds her way back to the beach where she was born and nests there, she completes the ancient, natural cycle that keeps sea turtles alive on Earth. Imagine a turtle imprisoned in a bucket, tub, or garbage can, swimming endlessly in tiny circles, never to see the open ocean, never to meet another turtle, never to help its species survive.

Sea turtles all over the world are dwindling in number. All species are listed as threatened or endangered under the U.S. Endangered Species Act, including our own green and hawksbill sea turtles. If we want our children and grandchildren to be able to see these huge, magnificent sea turtles swimming alive and free in the ocean, where they belong, we have to do our best to protect them now. The very best way we can to do that is by protecting the beaches where they nest, letting the baby turtles find their own way into the sea, and not hunting the big turtles. Future generations of turtles (and people) will thank us.

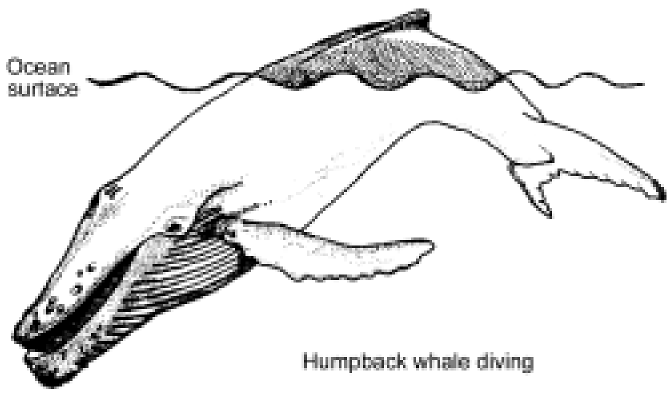
Holly Freifeld
DMWR



17. Whales Ho !

September and October are the peak months when humpback whales (*tafola*) visit our balmy waters. It's almost impossible not to get excited when one is spotted. Most of us feel inexplicably privileged for a brief glimpse into their mysterious world, and there's an uncontrollable urge to shout 'thar she blows'.

Part of our fascination with whales is their huge size, of course. Adult humpbacks *(Megaptera novaeangliae*) grow up to 50 feet long and weigh about 40 metric tons (which equals the combined weight of 200 sumo wrestlers). We rarely get a chance to see the whole whale, except when they make a spectacular leap ("breach") out of the water. We usually see only their air spout or their humped back as they prepare to dive:

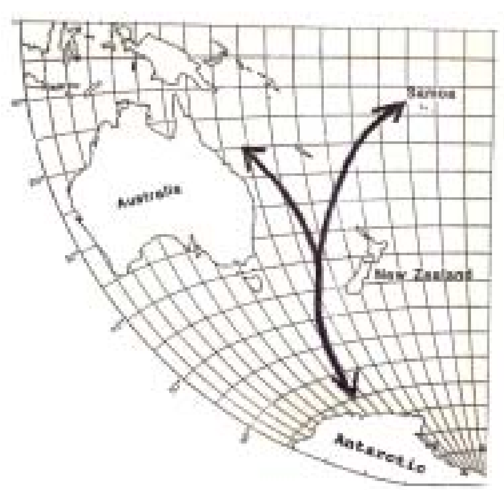


Humpback whale diving

Humpbacks are air- breathing mammals (like ourselves) that live their complete lives in the ocean. They reproduce like all land mammals, but they do it underwater. Whales obviously have to make sure that their babies don't drown while being born. Mother whales nurse their young for about a year.

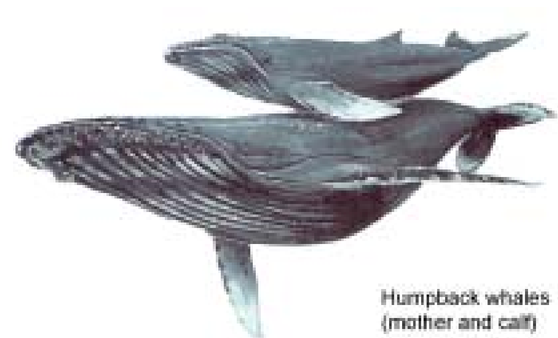
These whales eat small schooling fishes and krill (small shrimps). They feed by sucking in tons of water in a single mouthful, and then strain the food out as they expel the water. The out- going water is filtered through specialized structures called "baleen", which looks (with a little imagination) like a mouthful of coconut fronds. Humpbacks lack real teeth because they have no need to bite or chew their tiny food items. It seems odd that the whale, which is one of the world's largest animals ever, feeds on such small things.

The appearance of humpbacks in Samoa is an important segment of their grand migration up and down the South Pacific Ocean. During the warm months of the southern hemisphere, our whales feed in the rich waters of Antarctica, located 3,200 miles to the south of us (see map). Biologists call this particular group of whales the "Group- 5 Antarctic stock". When Antarctic's bitter winter sets in, the Group- 5 whales seek warmer waters. They migrate northward, with some going towards Australia and others migrating towards Tonga. Apparently most of this latter group remains near Tonga, but at least some migrate onward to Samoa. However, one of our whales was sighted near Tahiti, so their migration patterns still hold some surprises for us.



A few humpbacks might arrive in Samoa as early as July or leave here as late as December, but they are most common here in September and October. They occur in small groups of adults or in mother- calf pairs. Humpbacks have been sighted around all 7 of the islands in the Territory, but we don't know how many are actually here. They migrate here to mate and give birth to their young. And, interestingly, they stop feeding while here - - only when they return to the Antarctic do they resume feeding.

While an occasional spout of whale- breath can be seen in our local waters, you can also hear the whales if you stick your head in the water. Humpbacks are famous for their unique “songs”. Yes, whales sing! During mating season, male humpbacks sing to either attract females or to defend their territory from other male whales, much like birds do with their own songs.



Humpback whales (mother and calf)

The whale's song is haunting and complex. It sounds like a eerie series of chirps, squeaks, whistles and grunts. I know that “grunts” don't seem like they could make much of a song, but you just have to take my word for it. It is unlike anything you have ever heard. Scuba divers can hear the singing if the they hold their breath and pay attention. Snorkelers can also hear the songs, but they have to dive at least 10 feet deep to get below the noisy surface layer of water. The song lasts about 10- 20 minutes, it has a beginning, middle and end, and all males of the same stock sing the same song. Biologists can therefore identify where a whale comes from by listening to its song. For example, Hawaiian humpbacks sing a different song (than the Samoan humpbacks), because they belong to a different stock of whales that migrates between Hawaii and Alaska. The whales' song is one of the world's wonders of nature and it's at our doorstep.

Humpback whales are currently listed as an endangered species because their world- wide populations were decimated by whalers in the 1800's and 1900's. By the time commercial whaling was stopped in 1966, 95% of our stock (Group- 5) had been killed. Recovery of Group- 5 has been unexpectedly slow, probably due to continued whaling by Soviet factory ships as late as 1972 and a subsistence harvest of these whales occurred in Tonga up to 1978. In any event, whales in American Samoa remain few in number, and in some years hardly any are seen here.

Because humpbacks use our waters to give birth to their young, it is important to protect them when they are here. Enjoy their presence, but don't pester them. Avoid the temptation to boat right up to them or follow them at close quarters. Boaters, divers and swimmers should stay at least 100 yards away, and watch from there.

P. Craig, NPS